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Research Article

Relationship between Pulmonary Tuberculosis and Malnutrition in Urban Slums of Howrah District

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Abstract

Tuberculosis (TB) remains a significant public health challenge, particularly in low and middle-income countries like India. Despite advancements in diagnosis and treatment, TB continues to cause substantial morbidity and mortality, exacerbated by malnutrition, which compromises immune function and increases susceptibility to infections. Urban slum areas, characterized by poor access to nutritious food, inadequate sanitary conditions, and limited healthcare resources, exhibit a higher burden of malnutrition and TB. Howrah, a densely populated district in West Bengal, is known for its extensive slum areas, where residents face significant health disparities driven by economic instability and lack of social support systems.

This study conducted in the urban slums of Howrah district explores the relationship between pulmonary tuberculosis (TB) and malnutrition, revealing that 43.75% of TB patients were malnourished, with males being disproportionately affected. A significant association was observed between malnutrition and gender. Furthermore, 31.25% of patients did not receive benefits under the Ni-kshay Poshan Yojana (NPY), a critical support scheme for TB patients, exacerbating poor nutritional outcomes. Behavioral risk factors such as tobacco chewing (30.21%) and alcohol consumption (9.38%) were prevalent and further deteriorated the health conditions of the patients. These findings highlight the pressing need for ensuring universal access to NPY benefits and addressing malnutrition through gender-sensitive nutritional support programs and awareness campaigns. Interventions targeting risk behaviors like tobacco and alcohol use are also essential to improve the overall health and treatment outcomes for TB patients in these vulnerable urban communities.

Keywords: Pulmonary TB; Mal-Nutrition; Urban Slums; Ni-Kshay Poshan Yojana; Howrah District

Abbreviations

TB: Tuberculosis; NPY: NI-Kshay Poshan Yojana; NGO: Non Government Organization; WHO: World Health Organization; BMI: Body Mass Index; MDR-TB: Multi Drug Resistant Tuberculosis; RR-TB: Rifampicin Resistant Tuberculosis; NCD: Non-Communicable Disease; NTEP: National Tuberculosis Elimination Program; HIV: Human Immuno Deficiency Virus; TU: Tuberculosis Unit; SDG: Sustainable Development Goals; SES: Socio-Economic Status

Introduction

The disease is called by some "The Mother of Diseases" and is as much a *social disease* [1] as an infectious disease. TB is associated with poverty, overcrowding, alcoholism, stress, drug addiction and malnutrition. The disease spreads easily in overcrowded, badly ventilated places and among people who are undernourished. This has lead to TB being known as a disease of poverty. The World Health Organization (WHO) estimates that there are about 10.4

million new cases and 1.8 million deaths from TB each year. One-third of these new cases (about 3 million) remain unknown to the health system, and many are not receiving proper treatment [2]. The WHO has declared TB to be a global emergency and has called for urgent and extraordinary action [3].

In the 21st century, tuberculosis is still the most frequent underlying cause of wasting worldwide. However, patho-physiology of wasting in tuberculosis remains poorly understood [4]. Indeed, the association between TB and malnutrition is bi-directional since malnutrition may also result from TB itself, driven by inflammation-related cachexia, anorexia, and mal absorption [5] and tuberculosis can contribute to malnutrition [6].

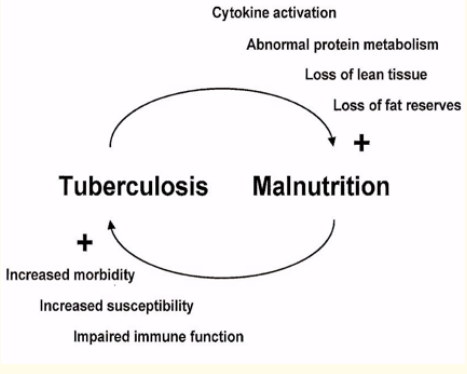

Figure 1: Bi-directional interaction of TB& malnutrition & some putative mechanisms [1].

Hunger-related malnutrition predisposes individuals to TB (increasing the risk by 6–10 times) and is a risk factor for the progression of latent TB infection to active TB, with the reactivation of latent TB often heralded by a low body mass index (BMI) [8]. The risk of TB has been found to increase by 13.8% with each unit decrease of BMI [9]. Poor nutritional status in MDR-TB is associated with a longer time to sputum conversion [10], worse treatment outcomes [11],and higher mortality [8,12]. Multidrug- and Rifampicin-resistant tuberculosis (MDR/RR-TB) patients presenting with malnutrition have a greater risk of experiencing ≥3 side-effects of treatment and death compared to nutritionally replete patients [12]. TB is commonly accompanied by co-morbidities such as diabetes, smoking and alcohol or substance abuse (risk factors for NCDs), which also carry their own nutritional consequences.

Poor nutritional status, a common cause of secondary immunodeficiency, is implicated in impaired innate and adaptive immune responses by attenuating or inhibiting aspects of the Myco-bactericidal response, cell-based immunity, and cytokine release {such as tumor necrosis factor α (TNF-α), interferon γ (IFN-γ), and interleukin 12 (IL-12)} [13]. Altered body composition or impaired gastrointestinal function due to under-nutrition may alter the pharmacokinetics and pharmaco-dynamics of TB medications and can result in treatment failure or increased toxicity [14]. Malnutrition-associated changes may result in variable drug absorption, volume of distribution, serum concentrations, drug efficacy, and drug toxicity, and can lead to suboptimal dosing, treatment failures, and the development of drug resistance [15,16].

Addressing relationship between (mal-)nutrition and pulmonary TB has the potential to yield benefits not only for tackling the TB pandemic but also precipitate a cascade of improvements for public health in general, and advance progress toward Sustainable Development Goals (SDGs) 1, 2, and 3 (no poverty, zero hunger and good health and well-being, respectively). The growth of MDR/RR-TB and its more severe forms have also renewed interest in the role of nutritional interventions as a preventative and therapeutic tool.

In Howrah district, urban slums face high prevalence rates of both pulmonary TB and malnutrition, reflecting the socio-economic vulnerabilities of the population. Despite efforts under the National Tuberculosis Elimination Program (NTEP), the intertwined challenges of TB and malnutrition persist, undermining the effectiveness of public health interventions. Exploring this relationship is essential to design integrated interventions that address both conditions effectively. This study aims to examine the association between pulmonary TB and malnutrition in the slums of Howrah, providing evidence to guide policy-making and program planning in such settings.

Objectives of the Study

- To estimate the prevalence of malnutrition in patients with pulmonary tuberculosis in urban slums of Howrah District
- To identify the socio-demographic factors associated with malnutrition in patients with pulmonary tuberculosis

Materials and Methods

To investigate the relationship between pulmonary tuberculosis (TB) and malnutrition in the urban slums of Howrah district, a robust methodological framework is essential. The study aims to assess the prevalence of malnutrition among TB patients and to identify socio-demographic factors associated with it. Given the socio-economic and environmental vulnerabilities of urban slum populations, the methodology is designed to capture a comprehensive picture of the interplay between these two conditions.

- **Study Design:** Descriptive cross-sectional study
- **Study Setting and Timeline:** Urban slums of Howrah district [6 months]

Howrah district in West Bengal, India, is home to several densely populated urban slums, including Pilkhana, Tikiapara, Kadamtala, and P.M. Bustee. These areas are characterized by overcrowded living conditions and limited access to healthcare services, creating an environment conducive to the spread of tuberculosis (TB). As per the 2011 Census of India, Howrah district had a total population of 4,273,099. Within this, the urban population accounted for 3,074,144 individuals, comprising 1,591,300 males and 1,482,844 females.

- **Study population:** Patients with pulmonary tuberculosis residing in urban slums of Howrah district.
- **Sample Size:** Calculated based on prevalence data using formula

n = sample size

p= prevalence of TB infection, 48% (as estimated by Chauhan A, et al.[17])

q= 1-pi.e 52%

z=1.96(level of confidence two tail at 95%)

d= sampling error (10%)

n= = = 95.88 The final sample size will be **96.**

Sampling technique

The sampling design uses multi-stage sampling, where:

- Us covering urban slums are identified and narrowed down.
- Specific TUs are randomly selected at the first stage.
- Participants from the selected TUs are randomly chosen at the second stage.

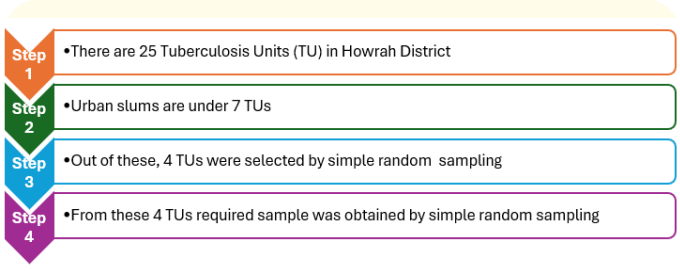

Figure 2

This technique reduces logistical complexity by focusing on specific TUs while maintaining randomness to avoid bias.

Population Identification

- There are 25 Tuberculosis Units (TUs) in the Howrah district.
- Among these, 7 TUs cover urban slums, which form the focus area for the study.

First Stage: TU selection

Using simple random sampling, 4 TUs out of the 7 covering urban slums were selected. This ensures unbiased selection of TUs for the study.

Second Stage: Sample selection from TUs

From each of the selected 4 TUs (Dumurjola TU, DTC, HMC-South, HMC- north), the required number of study participants (total 96 samples) was obtained using simple random sampling. This ensures that individual participants were selected randomly from within the selected TUs.

Inclusion criteria

- Confirmed pulmonary TB patients (age >18 yrs) who are resident of urban slums
- Pulmonary TB patients (age >18 yrs) who are resident of urban slums and who are willing to participate in the study

Exclusion criteria

- Patients with pulmonary TB with mental or physical disabilities that impair participation.
- Pregnant women with pulmonary TB

Study variables

Dependent variable

Nutritional status of pulmonary TB patients (age >18 yrs) who are resident of urban slums

Independent variable

- Age
- Gender
- Socio-economic status
- Living conditions
- Education
- Occupation
- Lifestyle factors (eg.- smoking, alcohol use)
- Marital status

Data collection Tools and Techniques

TOOLS

- **Structured Questionnaire:** It was used to collect socio-demographic information and other relevant factors. It was prepared in local vernacular (Bengali & Hindi).
  - Weighing machine
  - Measuring tape
- **Medical Records:** It was used for confirmed cases of pulmonary TB based on clinical and microbiological evidence.

Technique

- **Direct Interview:** Information was collected by direct interview of the respondents.
- Measurements of anthropometric parameters (Height, Weight, Body Mass Index etc) were done by using weighing machine and measuring tape.

Data analysis

After data collection, the data were entered into computer readable format in MS excel.

All the statistical analysis & interpretation were done by using MS excel. Data was organized in identifiable sections, statistical methods and descriptive statistics (by mean, standard deviation etc) were used to interpret the study variables.

Informed Consent

Informed consent (in local language) was taken from all the willing participants before conducting the research.

Mal-nutrition: operational definition

The World Health Organization (WHO) defines malnutrition operationally as a condition resulting from deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients. It encompasses both under-nutrition and overweight/obesity.

WHO operational definitions for malnutrition for adults

BMI(Body Mass Index): BMI is a common way to classify a person's weight-for-height, and can help determine if they are underweight, healthy weight, overweight, or obese.

BMI RANGE AND CATEGORY CHART

CATEGORY	BMI RANGE kg/m²
Underweight	<18.5
Normal Weight	18.5 - 24.9
Overweight	25 - 29.9
Obese	>30

Figure 3

(Figure 3)

Risks of the study

There is no risk to the study participants. Information provided by the respondents are restricted within the research team. Moreover this study is not related to providing any interventions like medical, surgical or instrumental. No invasive procedure was done.

Benefits of the Study

- **Insight into Public Health Issues:** It provides critical information about the intersection of tuberculosis, malnutrition, and urban poverty, contributing to public health strategies.
- **Targeted Interventions:** It identifies specific vulnerabilities and risk factors, enabling targeted interventions to improve healthcare delivery and outcomes in similar settings.

- **Personal Awareness:** Through the study, participants gained insights into their own health and nutritional status.

Ethical clearance

Ethical clearance was obtained from Institutional Ethics Committee, Institute of Health & Family Welfare, Kolkata.

Results

Variables	Attributes	Frequency	Percentage (%)
AGE[19](in yrs)	18 – 24	22	22.91
	25 – 44	33	34.38
	45 – 60	27	28.13
	61 – 75	12	12.50
	76 – 90	2	2.08
GENDER	Male	60	62.50
	Female	36	37.50
FAMILY TYPE	Nuclear	82	85.42
	Joint	14	14.58
NO. OF FAMILY MEMBERS	1 – 3	44	45.84
	4 – 6	43	44.79
	>6	9	9.37

Table 1: Distribution of Participants according to Demographic Profile(n = 96).

Comments

- **Age and Gender:** The majority of TB patients are in the working age group (25–44 years, 34.38%) and predominantly male (62.5%), reflecting the vulnerability of economically active individuals to TB.Males (62.50%) outnumber females (37.50%), which aligns with TB prevalence trends, as men are often more exposed to risk factors like smoking, alcohol, and occupational hazards.
- Nuclear families (85.42%) and small family sizes (45.84% with 1–3 members) dominate the study population.

Comments

- A significant proportion belongs to the lower middle class (36.45%) and middle class (28.13%). Only 5.22% were in the upper class, indicating the role of poverty in TB prevalence.
- Daily laborers (19.79%), unemployed individuals (22.92%), and self-employed persons (17.70%) constituted a major group. Their precarious working conditions and poor nutritional intake contribute to malnutrition and TB vulnerability.
- Primary-level education (41.68%) is most common, which might limit awareness about TB and its nutritional implications.
- Most participants are married (56.25%), suggesting household-level influences on health and nutrition.

Comments

- Symptoms such as loss of appetite (17.71%) and nausea (9.38%) affect eating, further contributing to malnutrition among TB patients.
- 66 individuals (68.75%) receiving Ni-kshay Poshan Yojana (NPY) highlights the government's effort to address malnutrition among TB patients. Malnutrition, prevalent in slum populations, worsens TB outcomes by weakening immunity, while TB exacerbates malnutrition due to increased energy demands and reduced appetite. NPY's financial support for nutrition aims to break this cycle. However, the fact that 31.25% did not receive benefits indicates gaps in coverage, emphasizing the need for improved access and program outreach to enhance TB recovery and nutritional rehabilitation in vulnerable populations.

Variables	Attributes	Frequency	Percentage (%)
RELIGION	Hindu	69	71.88
	Muslim	26	27.08
	Christian	1	1.04
CASTE	UR	83	86.45
	SC	8	8.34
	ST	3	3.13
	OBC	2	2.08
MARITAL STATUS	Single	30	31.25
	Married	54	56.25
	Divorced	4	4.16
	Separated	1	1.05
	Widow	7	7.29
EDUCATION	Illiterate	13	13.54
	Primary	40	41.68
	Secondary	21	21.88
	Higher secondary	11	11.45
	Graduation & above	11	11.45
OCCUPATION	Student	10	10.42
	Un-employed	22	22.92
	Employed	12	12.50
	Self employed	17	17.70
	Home maker	16	16.67
	Daily labourer	19	19.79
SOCIO-ECONOMIC STATUS(as per BG Prasad's SES,2024)[20]	Upper class (9098 & above)	5	5.22
	Upper Middle Class (4549 – 9097)	25	26.04
	Middle class (2729 – 4548)	27	28.13
	Lower middle class (1364 – 2728)	35	36.45
	Lower class (<1364)	4	4.16

Table 2: Distribution of Participants According to Socio-economic Profile(n = 96).

Variables	Attributes	Frequency (n = 96)	Percentage (%)
PREVIOUS TB EPISODE	Yes	25	26.04
	No	71	73.96
COMORBIDITY	Diabetes	17	17.71
	Hypertension	2	2.08
	Both	4	4.17
	HIV – AIDS	2	2.08
	Psychiatric Problem	3	3.13
	Thyroid Disorder	1	1.04
	None	67	69.79
ADDICTION	Smoking	7	7.29
	Alcohol	9	9.38
	Both	5	5.21
	Chewing Tobacco	29	30.21
	Others	2	2.08
	None	44	45.83
TYPE OF DIET	Vegetarian	6	6.25
	Non Vegetarian	90	93.75
NO. OF MEALS PER DAY	Two	3	3.12
	Three	33	34.38
	>Three	60	62.50
NUTRITIONAL SUPPLEMENT USE	Yes	44	45.83
	No	52	54.17
ASSOCIATED SYMPTOMS AFFECTING EATING	Loss of appetite	17	17.71
	Nausea & vomiting	9	9.38
	Easy satiety	3	3.13
	Altered taste	3	3.13
	Nothing as such	64	66.65
RECEIVE NPY	Yes	66	68.75
	No	30	31.25

Table 3: Clinical and Nutritional Profile of Study Participants (n = 96).

- Most participants (93.75%) are non-vegetarian, but only 34.38% have three meals daily, highlighting inadequate food intake.

Comments

35.42% of participants are underweight (BMI <18.5) which demonstrates a strong prevalence of malnutrition among TB patients. Normal nutritional indicator (BMI 18.5–24.9) is common but suggest a broader range of nutritional deficiencies.

Variables	Attributes	Frequency(n=96)	Percentage (%)
HEIGHT	<5 ft	26	27.08
	5 ft – 6 ft	69	71.88
	>6 ft	1	1.04
WEIGHT	20 – 40 kg	20	20.83
	41 – 60 kg	66	68.75
	61 – 80 kg	9	9.38
	>80 kg	1	1.04
BMI(in kg/)	Under weight[1](<18.5)	34	35.42
	Normal(18.5-24.9)	54	56.25
	Over weight(25-29.9)	8	8.33

Table 4: Distribution of Participants According to Anthropometric Measurements (n = 96).

Variables	Max.	Min.	Mean	Median	Mode	Sd	Se
AGE (in yrs)	78	18	41.70833333	42	20	16.36743665	1.670494508
HEIGHT (meter)	1.9824	1.22	1.560741667	1.5665	1.6012	0.111770467	0.011407526
WEIGHT (in kg)	83	28.7	48.12541667	47.75	54	9.711540386	0.99117994
SES(as per BG Prasad's scale,2024)	32500	750	4171.340625	3071.43	2500	3746.393428	382.3646781
BMI (in kg/)	29.09	11.55	19.80989583	19.65	17.24	3.693316722	0.376947559

Table 5: Descriptive Statistics of Study Population (n = 96).

Prevalence of Mal-nutrition among Pulmonary TB Patients (n = 96)

Total no of malnutrition (both under-nutrition &over-nutrition) = 34+8 = 42

[BMI < 18.5 = 34 individuals & BMI (25 – 29.9) = 8]

Prevalence = × 100%

= × **100% = 43.75%**

In the context of this study, the calculated prevalence of malnutrition (both under-nutrition and over-nutrition) is 43.75%. This indicates that nearly half of the study population exhibits some form of malnutrition, highlighting a significant public health concern.

Comments

- **Under-nutrition dominates:** Of the 42 malnourished individuals, 34 (81%) fall into the under-nutrition category (BMI < 18.5).Under-nutrition is a well-established risk factor for TB as it weakens the immune system, making individuals more susceptible to infection and disease progression.
- **Over-nutrition exists but less prevalent:** The remaining 8 individuals (19%) have BMI values between 25 and 29.9, indicating overweight status. While less common in this setting, over-nutrition may also contribute to TB risk due to associated metabolic disturbances.
- **Burden of malnutrition:** High malnutrition prevalence highlights the dual burden of under-nutrition and over-nutrition in this vulnerable population. Nutritional deficiencies exacerbate TB susceptibility, severity, and treatment outcomes.

Distribution of Participants as per Gender and BMI status

GENDER	BMI(in kg/)			TOTAL	Chi square, df, p-value
	<18.5 No. (%)	18.5-24.9 No. (%)	25-29.9 No. (%)		
MALE	26 (43.33)	32 53.33)	2 (3.33)	60	=7.87 df=2 p value=0.0195
FEMALE	8 (22.22)	22 (61.11)	6 (16.66)	36	
TOTAL	34	54	8	96	---

Table 6

- There is a statistically significant association between gender and BMI in this population. Males are more likely to be underweight, whereas females show a relatively higher proportion of normal and overweight BMI categories.
- This indicates gender-related differences in nutritional status among pulmonary TB patients, which could be influenced by socio-cultural, dietary, or health-related factors in this urban slum context.

Distribution of Participants as per Meals/Day and BMI status

- The chi-square value is 1.2921 with 2 degrees of freedom.The p-value is 0.524116, which is greater than the standard significance level of 0.05.
- There is no statistically significant association between the number of meals consumed per day and BMI in this population.Nutritional status (as measured by BMI) appears to be independent of the number of meals consumed daily.

MEALS/DAY[1]	BMI(in kg/)			TOTAL	Chi square, df, p-value
	<18.5 No. (%)	18.5-24.9 No. (%)	25-29.9 No. (%)		
2 - 3	15 (41.67)	19 (52.78)	2 (5.56)	36	=1.2921 df=2 p value=0.52411
>3	19 (31.67)	35 (58.33)	6 (10)	60	
TOTAL	34	54	8	96	---

Table 7

1. To ensure the statistical validity of the chi-square test, data were regrouped to meet Cochran's assumption, which states that at least 80% of the expected cell frequencies should be greater than 5. This regrouping was necessary to maintain statistical robustness and avoid violations of the test's assumptions.

Distribution of participants as per type of diet and BMI status

There is no significant association between diet type (protein-based or non-protein-based) and BMI categories. This suggests that in this study population, the type of diet is not a determining factor for achieving a BMI above or below the median value (19.65 kg/m^2).

Distribution of Participants as per Nutritional Supplements and BMI status

- At a 95% confidence level, the p-value (0.222) is greater than 0.05. This indicates that there is **no statistically significant association** between the use of nutritional supplements and BMI categories in this population.
- Nutritional interventions alone may not suffice to address malnutrition in this setting.

USE OF NUTRITIONAL SUPPLEMENTS	BMI (in kg/)			TOTAL	Chi square, df, p-value
	<18.5 No. (%)	18.5-24.9 No. (%)	25-29.9 No. (%)		
Yes	19(43.18)	23(52.27)	2(4.55)	44	= 3.01 df=2 p-value=0.222016
No	15(28.85)	31(59.62)	611.54)	52	
TOTAL	34	54	8	96	---

Table 9

Distribution of Participants as per Co-morbidity and BMI status

- The p-value (0.102252) is greater than the significance level of 0.05. This indicates no statistically significant association between the presence of co-morbidities and BMI in this study population.
- Although individuals with co-morbidities may have varying BMI statuses, the lack of a statistically significant association suggests that co-morbidities alone are not a key determinant of malnutrition in this population.

CO-MORBIDITY	BMI(in kg/)			TOTAL	Chi square, df, p-value
	<18.5 No. (%)	18.5-24.9 No. (%)	25-29.9 No. (%)		
Present	8(26.67)	17(56.67)	5(16.67)	30	= 4.5606 df=2 p value=0.102252
Absent	26(39.39)	37(56.06)	3(4.55)	66	
TOTAL	34	54	8	96	---

Table 10

Distribution of participants as per receipt of NPY and BMI status

- The p-value (0.131332) is greater than the significance level of 0.05. This indicates no statistically significant association between receiving NPY benefits and BMI in this study population.

Distribution of Participants according to Addiction and BMI status

- The test statistic (χ^2) is 0.3991, and the p-value is 0.527572. Since the p-value is greater than 0.05, the result is **not statisti-**

RECEIVE NPY	BMI(in kg/)			TOTAL	Chi square, df, p-value
	<18.5 No. (%)	18.5-24.9 No. (%)	25-29.9 No. (%)		
YES	19 (28.79)	41 (62.12)	6 (9.09)	66	= 4.0601 df = 2 p value = 0.131332
NO	15 (50)	13 (43.33)	2 (6.67)	30	
TOTAL	34	54	8	96	---

Table 11

cally significant. This means there is no evidence of a significant association between addiction and BMI in this population.

- This suggests that other factors, such as poverty, food insecurity, or the metabolic impact of TB itself, might play a larger role influencing malnutrition.

Distribution of Participants as per Socio-economic Status and BMI status

- Prevalence Odds ratio = = 1.8
- Standard Error (SE) of In (OR): 0.413.
- Upper bound = In (1.8) + 1.96×0.413 = 1.399, upper limit = = 4.05
- Lower bound = In (1.8) - 1.96×0.413 = -0.219, lower limit = = 0.80
- This means the odds ratio of 1.8 has a 95% confidence interval ranging between 0.80 and 4.04.
- As the 95% of OR includes **1**, it denotes that SES doesn't have any effect on BMI in spite of OR of 1.8.

ADDICTION	BMI(in kg/)Median BMI 19.65 kg/		TOTAL	Chi square, df, p-value
	≥ 19.65 No. (%)	< 19.65 No. (%)		
Present	25 (48.08)	27 (51.92)	52	= 0.3991 df = 1 p value = 0.527572
Absent	24 (54.55)	20 (45.45)	44	
TOTAL	49	47	96	---

Table 12

Socio-Economic Status	BMI(in kg/) Median BMI 19.65 kg/		Total
Median = INR 3071.4.3	≥ 19.65 No. (%)	< 19.65 No. (%)	
≥3071.4.3	28(58.33)	20(41.67)	48
< 3071.4.3	21(43.75)	27(56.25)	48
TOTAL	49	47	96

Table 13

Discussion

Pulmonary tuberculosis (TB) remains a significant public health concern in India, with urban slums being particularly vulnerable due to factors such as overcrowding, poor sanitation, and limited access to healthcare. Malnutrition is a known risk factor for the onset and progression of TB, as it weakens the immune system, making individuals more susceptible to infections. In the urban slums of Howrah district, where poverty, inadequate nutrition, and poor living conditions are prevalent, the interplay between TB and malnutrition becomes a critical issue.

This study aims to explore the relationship between pulmonary tuberculosis and malnutrition in the urban slums of Howrah, focusing on various demographic, socioeconomic, and health factors that may contribute to the incidence and severity of the disease. By analyzing data on nutritional status, co-morbidities, and other determinants such as age, gender, and socioeconomic status, this research seeks to shed light on the underlying causes of TB in a marginalized population. Understanding the link between malnutrition and TB is essential for developing targeted interventions to improve health outcomes and reduce the burden of TB in these high-risk communities. The findings indicate a significant association between TB prevalence and poor nutritional status, particularly under-nutrition, highlighting the compounded health challenges faced by residents in these areas. The demographic, socioeconomic, and health characteristics of the study participants offer valuable insights into the complex interplay between pulmonary TB and malnutrition.

The study sample primarily consisted of individuals aged between 25–44 years (34.38%) and 45–60 years (28.13%), which aligns with other studies that report higher TB incidence among adults in the working age group. In a study conducted by Subramanian SV., *et al.* (2015) [21]. in urban slums of India, TB was most prevalent in the age group of 25-44 years, which is consistent with the findings of this study. The study found that the majority of participants were between the ages of 18–44 years (57.29%), a group commonly affected by TB in urban slums, where young adults often bear the burden of communicable diseases due to their active participation in the labor market and exposure to environmental risk factors. Similar trends were observed in a study by Banu S., *et al*. (2017) [22], which reported that TB is most prevalent in the economically active age group, likely due to increased exposure to crowded living conditions and limited access to healthcare.

In terms of gender, 62.5% of participants were male, which mirrors the gender distribution found in other studies of TB in slum settings (Das et al., 2020) [23]. The gender distribution in the study is consistent with the global trend where TB is more common in males, possibly due to higher exposure to environmental risk factors and lifestyle habits such as smoking and alcohol consumption (World Health Organization, 2023) [24].

A notable finding from this study is the predominance of participants from lower socioeconomic backgrounds, with 36.45% falling in the lower middle class category, and 4.16% in the lower class. Studies in other urban slum areas, such as those conducted in Mumbai (Kamat et al., 2017) [25], have similarly highlighted a strong link between poverty and increased vulnerability to both TB and malnutrition. Poverty in urban slums often leads to poor access to nutritious food, inadequate healthcare, and overcrowded living conditions, all of which contribute to the spread of TB and the deterioration of nutritional status. The higher prevalence of under-nutrition in this population, as indicated by 35.42% having a BMI <18.5, further reveals the role of socioeconomic deprivation. These findings are consistent with studies by Sharma et al. (2018)[26], which found that malnutrition is a critical risk factor for the development and progression of TB, especially in impoverished settings.

The majority of participant was married (56.25%) and lived in nuclear families (85.42%), which is consistent with other studies that show that family dynamics and marital status can influence health behaviors and access to care. Nuclear families in urban slums may face more isolation, which could affect the support system available for those suffering from TB, as seen in a study by Shah P., et al. (2020) [27]. Additionally, marriage and family structure can impact the nutritional status of individuals, as they may share limited resources within the family, further exacerbating malnutrition.

Nutritional intake is a key factor in the relationship between TB and malnutrition. In this study, the vast majority of participants (93.75%) followed a non-vegetarian diet, which is commonly associated with higher protein intake. However, 19.79% of participants reported dietary restrictions, and 45.83% used nutritional supplements, suggesting that access to balanced diets and supplementation remains a concern in this population. Studies by Gautam S., *et al.* (2016) [28] in slums of Delhi have similarly noted that malnutrition is prevalent even in populations with access to non-vegetarian food, due to poor overall diet quality and food insecurity. The high incidence of symptoms like loss of appetite (17.71%) and nausea (9.38%) further indicates that TB-related symptoms may interfere with adequate food intake, worsening the nutritional status of individuals. This observation is consistent with findings from a study by Kumar P., *et al*. (2019) [29], which showed that TB patients often suffer from reduced appetite and gastrointestinal disturbances, further contributing to malnutrition. Additionally, 45.83% of participants used nutritional supplements, a practice that may help mitigate some of the effects of malnutrition. However, the fact that over half of the participants (54.17%) did not use supplements reveals the ongoing gap in nutritional support, which is crucial for TB patients to recover and improve treatment outcomes [30].

The presence of co-morbidities, such as diabetes (17.71%) and hypertension (2.08%), among participants highlights the added complexity in managing TB. Co-morbidities can worsen the nutritional status and increase the difficulty of TB treatment. Co-morbidities in some participants complicates TB treatment, as these conditions can interfere with both immune response and nutritional absorption, leading to poorer outcomes [31]. Similarly, addiction, particularly tobacco chewing (30.21%) and smoking (7.29%), was common in this population. Tobacco use is a known risk factor for both the development of TB and the impairment of the immune system, making individuals more susceptible to infections and less responsive to treatment [32].

Over half of the participants (56.25%) had a BMI in the normal range, but the large proportion (35.42%) who were underweight suggests a high prevalence of malnutrition, which has been shown to significantly increase the risk of TB infection and mortality [33]. These findings are consistent with other studies on TB in slum populations, such as a study in Kolkata [34], where a substantial proportion of TB patients were found to be underweight. The findings are consistent with similar studies conducted in urban slums of Delhi, where malnutrition rates among TB patients were found to be alarmingly high, further supporting the hypothesis that malnutrition is both a risk factor and a consequence of TB.

A significant number of participants (26.04%) reported a previous TB episode. This suggests a cyclical problem in the population, where individuals who have been treated for TB may be at risk of relapse due to factors such as malnutrition, poor access to healthcare, and inadequate treatment adherence. Similar findings have been reported by [35] who highlighted that individuals who had a prior history of TB were at higher risk of recurrent infection in resource-poor settings.

These data highlights the strong intersection between socioeconomic factors, nutritional status, and TB prevalence, particularly in an urban slum setting, where poor living conditions and limited healthcare access contribute to both the spread and impact of TB.

Conclusion

"The fight against TB is also a fight against poverty, hunger, and inequity." Dr. Tedros Adhanom Ghebreyesus.

This study highlights the intricate relationship between pulmonary tuberculosis (TB) and malnutrition among residents of urban slums in Howrah district. The findings reveal that malnutrition is both a cause and consequence of TB, with 35.42% of participants being underweight , indicative of chronic nutritional deficits. These challenges are further compounded by socio-economic hardships, with 36.45% of participants belonging to the lower middle class and 26.04% having a history of TB episodes, suggesting cycles of disease and under-nutrition. Despite the high prevalence of non-vegetarian diets (93.75%), factors such as limited nutritional supplement use (45.83%), associated eating symptoms like loss of appetite (17.71%), and addictions (30.21% chewing tobacco) highlight critical gaps in achieving adequate nutrition. The majority (69.79%) reported no co-morbidities, but the presence of diabetes (17.71%) and other conditions points to a need for integrated healthcare approaches.

Government initiatives like TB Mukt Bharat, under the National Tuberculosis Elimination Program (NTEP), aim to break this vicious cycle by integrating nutritional support with TB care. Programs such as the Nikshay Poshan Yojana (NPY), which provides financial assistance for nutrition, have already reached 68.75% of participants, but the study emphasizes the need for expanded coverage and better implementation to address gaps.

Addressing the dual burden of TB and malnutrition requires not only medical interventions but also socio-economic reforms and community-level nutrition programs. As the study suggests, improving nutritional support and health education, particularly for vulnerable populations, can significantly enhance treatment outcomes and break the cycle of disease and deprivation.By integrating nutritional care into TB management strategies, public health programs can create a robust framework to combat this interlinked challenge and ensure better health equity for marginalized communities.

Conflict of Interest

There is no conflict of interest regarding this study.

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